Submitted to:
US EPA Region 8
Denver, CO

Submitted by:
Atlantic Richfield Company
La Palma, CA
May 31, 2013

2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel

Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado

Atlantic Richfield Company

Anthony R. Brown
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May 31, 2013

VIA EMAIL AND HAND DELIVERY

Mr. Steven Way
On-Scene Coordinator
Emergency Response Program (8EPR-SA)
US EPA Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Subject: 2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel – Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado

Dear Mr. Way,

A digital file in PDF format of the 2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado, dated May 31, 2013, is being submitted to you today via email. Three (3) hard copies of the report will be hand-delivered to your office no later than June 3.

Atlantic Richfield Company (AR) is submitting this report responsive to requirements in Task D – Hydraulic Control Measures for the Collapsed Area of the St. Louis Tunnel Adit / Subtask D1 – Adit Collapse Area Investigations of the Remedial Action Work Plan accompanying the Unilateral Administrative Order for Removal Action, Rico-Argentine Site, Dolores County, Colorado, U.S. EPA Region 8, Docket No. CERCLA-08-2011-0005.

If you have any questions or comments, please feel free to contact me at (714) 228-6770 or via email at Anthony.Brown@bp.com.

Sincerely,

Anthony R. Brown

Tony Brown
Project Manager
Atlantic Richfield Company

Enclosure (2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel)

cc: Terry Moore, Atlantic Richfield
Jerry Johnson, Atlantic Richfield
Chris Sanchez, AECI
Sandy Riese, EnSci
Dave McCarthy, Copper Environmental
Tom Kreutz, AECOM
Doug Yadon, AECOM
Steve Szocik, AECOM
Marc Lombardi, AMEC

2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel

Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado

May 31, 2013

Prepared for:

Atlantic Richfield Company
La Palma, CA

For submittal to:

US EPA Region 8
Denver, CO

Thomas M. Kreutz, PE
AECOM Project Manager

Douglas M. Yadon, PE
Certifying/Design Engineer

Steve Szocik
QA Manager

Title and Approval Sheet

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TABLES

FIGURES

ATTACHMENTS

DOCUMENT CONTROL LOG

Revision #	Prepared by	Reviewed by	Approved by	Date	Pages Affected
0	D. Yadon; E. Drumright; C. Sanchez	T. Brown, T. Moore, S. Riese, J. Johnson, S. Archer	T. Brown	5/31/2013	NA

DISTRIBUTION LIST[1]

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[1] Distribution in digital format unless noted otherwise.
[2] One hard copy sent.

1.0 Project Management

1.1 Project/Task Organization

AECOM Technical Services, Inc. (AECOM), in cooperation with Anderson Engineering Company, Inc. (AECI), and on behalf of Atlantic Richfield Company (AR), has prepared this 2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel. This document supplements two prior investigation plans (Atlantic Richfield Company, 2012; Atlantic Richfield Company, 2011a). Each of these plans is referred to informally as an Adit Investigation Plan (AIP). The work is to be performed in the area of the St. Louis Ponds, north of Rico, Colorado, within Dolores County at the Rico Tunnels Operable Unit OU01 of the Rico-Argentine Mine Site (Site). The Site location is shown on Figure 1.

The purpose of this section is to define the areas of responsibility and lines of authority for each organization and for the members of the AIP team to facilitate decision-making during completion of the work.

The project management organization is presented on Figure 2, with the responsibilities of team members described in the following sub-sections.

1.1.1 Regulatory/Permitting Agency

The U.S. Environmental Protection Agency (EPA) is responsible for overseeing AR's performance of work for consistency and compliance with the provisions of the EPA Remedial Action Work Plan (RAWP; EPA, 2011a) and the Unilateral Administrative Order for Removal Action (UAO; EPA, 2011b). EPA's designated On-Scene Coordinator (OSC) is Mr. Steve Way. The EPA or its oversight contractor will periodically be on-site during investigation activities.

1.1.2 Facility Owner

AR has the responsibility for implementing the work described in this 2013 Supplement to the AIP. AR will coordinate overall management and implementation of the St. Louis Ponds area investigation activities.

AR is responsible for complying with the UAO and has the authority to select and dismiss subcontractors for completion of the work. AR also has the authority to accept or reject plans and reports, recommendations of the Investigation Field Manager, and the materials and workmanship of the various subcontractors who may work on the Site.

1.1.2.1 Project Manager

Mr. Tony Brown is AR's Project Manager. Mr. Brown will be AR's key contact person for the EPA during the work. The Project Manager will also:

- Review and sign submittals and progress reports or authorize others to sign submittals and progress reports on his and AR's behalf.

- Certify that the investigation has been completed in accordance with the approved 2013 Supplement to the AIP.
- Sign the 2013 Geotechnical Investigations Data Report (in addition to the AECOM Certifying/Design Engineer).

1.1.3 Investigation Field Manager

Mr. Christopher Sanchez, CSP (AECI), will serve as the Investigation Field Manager. The duties of the Investigation Field Manager include:

- Report to the AR Project Manager and/or AR's on-site representative and to the Certifying/Design Engineer.
- Identify and coordinate scheduling of drilling and geophysical subcontractors, and the geophysical survey team member from AECOM.
- Oversee on-site investigation activities, including engineering geologic mapping and grab sampling, soil/rock boring, sampling and logging, and geophysical surveying.
- Chair on-site project meetings related to the investigation work.

1.1.4 Certifying/Design Engineer

Mr. Douglas M. Yadon, PE (AECOM), will serve as the Certifying/Design Engineer. The Certifying/Design Engineer is responsible for preparation of the final report resulting from the investigation work. In addition, the Certifying/Design Engineer or his designee will be responsible for:

- Selection of the number and location of borings, the type of sampling and depth of investigation at borings, design and installation of piezometers and/or monitoring wells, and the type and location of geophysical surveys.
- Periodic observation of the investigation work to assure that the work is consistent with the intent of the 2013 Supplement to the AIP and the anticipated design requirements.
- Direction of reduction, interpretation, and analysis of field and laboratory geotechnical data.
- Direction of the preparation of the laboratory testing program based on investigation results, and selection and oversight of the geotechnical laboratories.
- Inclusion of the supplemental field test results in the 2013 Geotechnical Investigations Data Report.
- Participate in key technical discussions with EPA, AR, AECI, and other project team members and subcontractors.

1.1.5 Health and Safety Officer

Mr. Christopher Sanchez, CSP (AECI), or his designee will serve as the Site's Health and Safety Officer (HSO). The HSO will ensure that all Health and Safety Plan (HASP) requirements are effectively implemented and enforced during investigation activities completed on-site.

1.1.6 Subcontractors

The drilling and geophysical subcontractors for this 2013 Supplement to the AIP will be identified and contracted by AECI with input and concurrence by AECOM and final authorization by AR. The geotechnical laboratories for this 2013 Supplement to the AIP will be identified and contracted by AECOM and/or AECI, with final authorization by AR. Information regarding the task-specific subcontractors will be provided to the EPA as those subcontractors are selected. The subcontractors will be responsible for supplying materials and labor to complete the investigation in reasonable conformity with the requirements of this 2013 Supplement to the AIP. As such, each subcontractor will be responsible for quality control (QC) to ensure that their work meets the requirements of this 2013 Supplement to the AIP. Quality Assurance (QA) for field activities and for work by any geotechnical laboratory contracted by AECI will be the responsibility of AECI. AECOM will be responsible for QA for any work performed in AECOM's geotechnical laboratory and for work by any geotechnical laboratory contracted by AECOM.

AECI, on behalf of AR and AECOM, will be responsible to ensure that all necessary EPA approvals, authorizations, and coordination for EPA oversight have been secured or arranged before any work at the Site is performed by any subcontractor.

The subcontractors will immediately notify their respective QC Officers of any unanticipated conditions encountered during the investigation that in their opinion differ materially from those anticipated based on the scope of work prepared by AECI or otherwise communicated to the subcontractors by AECI. The QC Officer shall in turn notify the Investigation Field Manager for any concurrence or direction to respond to the unanticipated condition(s). The Investigation Field Manager will receive input from the Certifying/Design Engineer in matters that will or could affect the integrity of the analyses or designs to be based on the results of the field investigation program, and from the QA Manager on matters affecting the quality and integrity of the information being developed during the investigation.

1.1.7 Quality Assurance (QA) Manager

Steve Szocik of AECOM will serve as the project QA Manager. He will remain independent from all team members generating data or performing data analyses or evaluations for work under this 2013 Supplement to the AIP, including AECOM, AECI, and subcontractors' staff, to ensure the integrity of the quality assurance functions. Mr. Szocik will oversee the QA procedures and maintain the QA file for this portion of the project as described further in various sections herein. This will include issuing revisions to QA procedures if/as necessary and appropriate over the course of the project. He will interface as necessary with subcontractor QC Officers through the Investigation Field Manager.

1.1.8 Quality Control (QC) Officers

Each subcontractor will designate a QC Officer. The QC Officer is responsible for:

- Performing observations and field and/or laboratory tests to verify that:
  - Regular calibration of investigation equipment is properly conducted and recorded.
  - The investigation equipment, personnel, and procedures do not change over time or that any changes are managed and documented properly (MOC process, etc.) and do not adversely impact the investigation process.
  - The boring and geophysical sampling/surveying and laboratory test data are accurately recorded and maintained.
- Identifying deficient work items and recommending corrective actions.
- Ensuring that agreed-upon corrective actions have been conducted and are sufficient to correct the deficiency.

Planned and actual locations for borings, piezometers/monitoring wells, and geophysical survey lines will be surveyed by AECI in an accurate and timely manner.

1.2 Problem Definition and Background

Conditions at the collapsed portion of the St. Louis Tunnel upgradient of the existing portal structure are described in the original AIP (Atlantic Richfield Company, 2011a) and in reports of the findings of two investigations to date implemented under that plan (Atlantic Richfield Company, 2011b, and 2013b – submittal pending). As shown on Figure 3, results from drilling under the original AIP and historic information found in archival records subsequent to the field explorations performed in 2011 and 2012 confirm that Hermosa Formation bedrock is present at approximate tunnel Station 3+20. It is apparent that the St. Louis Tunnel penetrated colluvium/talus for approximately 300 feet horizontally between the upgradient side of the portal structure and the bedrock contact. Approximately 40 feet of overlying displaced colluvium/talus is now present above the contact with Hermosa Formation bedrock at tunnel Station 3+20, as seen on Figure 3. The colluvium/talus penetrated by borings AT-2 and BAH-01 (Atlantic Richfield Company, 2011b) is a heterogeneous mixture of predominantly coarse-grained, low-plasticity to non-plastic soil with occasional large rock blocks. As described in Atlantic Richfield Company (2011b) and shown on the historic tunnel geologic mapping presented on Figure 4, the bedrock near the colluvium/talus contact is locally sheared and faulted, and lagging is indicated to extend approximately 40 feet into the bedrock section of the tunnel. There is also a mapped 33-foot-wide fault zone approximately 110 feet further into the tunnel from the bedrock contact with the colluvium/talus, from approximately Station 4+30 to 4+65 (Figures 3 and 4).

It is apparent from drilling and sampling of boring AT-2 (Atlantic Richfield Company, 2011b) that the collapsed debris at the upgradient end of the open portion of the remnant tunnel is impounding mine drainage, and that precipitated solids are accumulating on the tunnel floor in the ponded reach. Two inclined borings, CHI-101 and CHI-102, were to be completed as part of the 2012 exploration work. Two attempts were made to complete Boring CHI-102; however, due to the very difficult drilling conditions, the air rotary Symmetrix casing ring bit separated from the associated casing within the colluvium prior to reaching the target depth. All casing was left in place at both borings in anticipation of a further attempt at completion in 2013. The casing shoes were not recovered.

1.3 Data Gaps

Although conditions are generally believed to be understood based on the historical information and data collected to date, more detail is required to address the following identified key data gaps:

- Additional definition of drilling and/or excavation conditions in the colluvium and colluvial debris blocking access to the rock portion of the tunnel is needed to support design of an effective means to reach the targeted rock.

- Conditions in the lowermost rock portion of the tunnel must be further characterized to support final selection of the specific location of a bulkhead that can be constructed to be stable and reasonably water-tight. Available data indicates at least local shearing, fracturing, and the presence of mineralized veins through which it was apparently necessary to continue lagging from the colluvial portion of the tunnel.

- Further information is needed to confirm and better characterize the build-up of head and solids behind the blockage at the colluvium/rock interface, and to better define and understand shallow groundwater conditions in the colluvium as well as the hydraulic interaction of that groundwater with water discharging from the tunnel through the blockage. This information will support final selection and design of the means to access the bulkhead location, and to assess means to control water and solids during construction.

- Depth to bedrock in the vicinity of a potential high retaining wall associated with an open-cut option to access a bulkhead location is needed to support design of the anchoring system for such a wall.

Some of the information on groundwater conditions in the colluvium into which tunnel flows currently discharge will also support characterizations and evaluations to be performed under the Conceptual Site Model (CSM) Work Plan under development by AMEC Environment & Infrastructure, Inc. (AMEC). This includes especially the resistivity profiling and vertical monitoring wells described below in Sections 2.2.2 and 2.3.4, respectively.

1.4 Project/Task Description

The primary objectives of this 2013 Supplement to the AIP are to: 1) provide supplemental information to support selection of a means to reach, and design a hydraulic control system bulkhead in, the rock portion of the St. Louis Tunnel; 2) further investigate the condition of the debris-blocked portion of the adit and how it interfaces with competent rock at the brow of CHC Hill; 3) provide an access point far enough behind the blockage to measure water and accumulated solids depths in the tunnel to support assessment of means to control the water and solids during construction of the hydraulic controls; and 4) further assess the condition of the collapsed portion of the tunnel down-gradient of the blockage to support design of demolition and reconstruction in that area. Investigations to achieve these objectives are focused on collecting, controlling, and conveying the adit flow from the rock portion of the tunnel to a future water treatment facility, currently assumed to be upgradient of the existing Pond 18 in the prior Pond 19 area or adjacent ground to the east at the toe of the Soil Lead Repository.

The objectives described above for the current study will be met by implementing the tasks described in the subsequent sections of this 2013 Supplement to the AIP. Note that the tasks are described in the general order in which they will be performed, with the understanding that some of the tasks may overlap. Subsequent tasks may change based in part on the results of precedent tasks.

1.5 Quality Objectives and Criteria

The overarching goal of the work under this 2013 Supplement to the AIP is to fill data gaps described in summary terms in Section 1.3 above, and in more specific detail in Section 2.0 below. These data, and data acquired during prior (pre-UAO [EPA, 2011b]) investigations, the 2011 AIP work (Atlantic Richfield Company, 2011a), and the first Supplement to the AIP work in 2012 (Atlantic Richfield Company, 2012a), are and will continue to be used to support siting, technical analyses, and ultimately final design of the civil engineering and geotechnical aspects of the remedial actions to be proposed by AR and adopted by EPA for the hydraulic control measures to be implemented for the collapsed area of the St. Louis Tunnel Adit under Task D of the RAWP (EPA, 2011a).

Specific data quality objectives (DQOs) and associated criteria for the planned 2013 investigations are summarized in Table 1. The first column in the table describes the identified quality objectives, i.e., what information is to be acquired and the data gap that is to be filled. A brief description of the investigation(s) to be performed to meet each objective is provided in the second column. Qualitative criteria are presented in the third column, identifying the aspects of the objective that are most important to meet in order to fill the data gap. The criteria are qualitative rather than quantitative, given that in most instances specific quantitative measures are not applicable or they depend on the field conditions encountered. Minimum quantitative criteria are provided where appropriate in Section 2.0, where each of the planned investigations is described in some detail. For example, the planned number and location of borings are shown on Figure 5 and summarized in Table 2, and the minimum sampling/testing interval of standard penetration tests (SPTs) with depth is provided. Note that action limits, laboratory detection limits, and precision, bias, and method sensitivity are not judged applicable to the field and laboratory data to be acquired during these geotechnical investigations and are not further addressed in this 2013 Supplement to the AIP. Subsequent water level monitoring and groundwater quality sampling that may be performed in monitoring wells installed under this 2013 Supplement to the AIP will be controlled by the relevant SAP (Atlantic Richfield Company, 2013c) and QAPP (Atlantic Richfield Company, 2013d).

Detailed consideration has been given to prior data acquired at the Site as a significant part of the basis for identifying data gaps and developing the DQOs for this 2013 Supplement to the AIP. This consideration included assessment of the anticipated range of conditions that may be expected at each field exploration location and for each type of geotechnical testing planned.

All data collected under this 2013 Supplement to the AIP will be compared to nearby similar data previously collected as a check on the reasonableness and accuracy of the new data. It is important to recognize, however, that such a comparison must be made with appropriate professional judgment, given that geologic and geotechnical conditions can and do sometimes vary significantly over short distances, and conditions can change at any given location over time.

1.6 Special Training Requirements and Certifications

AECOM and AECI field and laboratory technicians and professionals performing work under this 2013 Supplement to the AIP will have the appropriate educational and professional qualifications and experience commensurate with their specific responsibilities. These staff will be approved by the Certifying/Design Engineer and Investigation Field Manager based on their knowledge of the assigned staff under their respective control. No other special training requirements or certifications are anticipated to be necessary at this time.

If special training and/or certifications become necessary during the course of the work due to changes in the field or laboratory tasks resulting from unknown Site conditions or changes in project evaluation or design requirements, the assigned staff will be re-qualified as having the required training and/or certifications or replaced by the Certifying/Design Engineer or Investigation Field Manager.

1.7 Documentation and Records

1.7.1 Report Format and Data Report Package

The results of the investigations to be performed under this 2013 Supplement to the AIP will be compiled and presented in a report to be titled the 2013 Geotechnical Investigations Data Report. The report will reference and summarize the objectives of the 2013 Supplement to the AIP; describe the scope, methods, and results of the 2013 investigations; describe and present the results of data validation; and provide an evaluation of the success in meeting DQOs. The data acquired during the field and laboratory investigations will be summarized in appropriate figures and tables, and the raw data provided in appendices.

A proposed Table of Contents for the 2013 Geotechnical Investigations Data Report is included herein as Table 3. Note that additional and/or revised subsections may be incorporated in the report depending on the results of the investigations. Also, note that the results of the investigations performed pursuant to the 2013 Supplement to the Field Sampling Plan (FSP; Atlantic Richfield Company, 2013a) will be included in this same report.

1.7.2 Other Project Documents

No other formal project documents are planned. Technical project files will be maintained by AECOM and AECI in accordance with the companies' standard practices.

1.7.3 Project Document Storage and Retention

Project documents are stored in a filing system structured in accordance with the ISO 9001:2008 standard on AECOM's secure Denver server, which is regularly and automatically backed up by AECOM's IT Department. The current back-up procedure is as follows:

- Full backups are performed on each server nightly, Monday through Sunday.
- Daily file servers and exchange database tapes are on a 4-week rotation. SQL and Oracle databases are on an 8-week rotation. For hourly backups, new data is appended to the hourly tape every hour.
- The tape is formatted when the Monday case for the same color comes back from the rotation. These tapes are kept in-house.
- Tapes from nightly backups will be sent off-site each day to a secure records storage and management facility. The oldest set of weekly tapes in the rotation that are stored off-site will be returned to the office and put back in rotation, with the exception of the last day of the month.
- Every last day of the month, the tape(s) will be permanently archived off-site to a secure records storage and management facility.

Pursuant to Section IX. WORK TO BE PERFORMED, Paragraph 39, Record Retention of the UAO (EPA, 2011b), all non-identical copies of records and documents that relate to the work under this 2013 Supplement to the AIP shall be preserved and retained for a period of 10 years following Notice of Completion of Work issued by EPA. At the conclusion of the document retention period, AR will provide EPA with at least 90 days' notice prior to the destruction of any records or documents previously retained that are related to the work under this 2013 Supplement to the AIP.

1.7.4 QA Project Plan

This 2013 Supplement to the AIP constitutes both the sampling plan and the QA Project Plan (QAPP) for the work described herein. When revisions are made to the 2013 Supplement to the AIP, the designated QA Manager will distribute the revised plan to the individuals identified on the Distribution List located following the Table of Contents. The listed individuals are then responsible for disseminating the revised plan to other members of their respective project teams as appropriate.

2.0 Data Generation and Acquisition

The following existing information has been reviewed and evaluated to support the planning and implementation of further investigations under this task and the subsequent preliminary design of hydraulic control structures/facilities under RAWP Task D (EPA, 2011a).

- Estimated grade and alignment of the St. Louis Tunnel and the subsequent excavations and apparent "collapse" of the portal area and lower tunnel reach (from existing historic mine plans and maps, and aerial photography from 14 years between 1950 and 2011)
- Geology of the portal area and lower tunnel reach from published geologic mapping and reports, and Site reconnaissance geologic mapping
- Results of the 2011 and 2012 Site exploration and laboratory testing

This section describes the basis for selection of specific locations and types of field investigations (i.e., sampling process design), sampling methods, and sample handling and custody.

2.1 Monitor Water Levels in the St. Louis Tunnel

The pressure transducer previously installed in boring AT-2 in the colluvium/talus reach of the tunnel will continue to be monitored and the results converted to water level (depth and elevation) in the tunnel at that location. If the transducer continues to foul excessively, hand measurements of the inclined depth to water will be made monthly when safe access is possible. An attempt will be made to install a pressure transducer in the tunnel through the casing and cored bedrock reach of boring BAH-01. The pressure transducer data is intended to collect seasonal data on variations in water level and hydraulic pressures in the St. Louis Tunnel. This data will be used in the selection and design of hydraulic control measures at the St. Louis Tunnel.

Pressure transducers will also be installed, if possible, in any inclined borings to be drilled as described in Section 2.3.1 that are successful in penetrating the St. Louis Tunnel.

2.2 Surface Geophysical Surveys

2.2.1 Refraction Microtremor

Three lines of refraction microtremor (ReMi) profiles (RM-201, RM-202, and RM-203) were planned for 2012 but were not completed due to a shortened exploration schedule. These profiles are planned to be completed in 2013, one parallel to and two transverse to the open portion of the tunnel, just west of the collapse area (see Figure 5). A fourth ReMi line RM-204 has been added just east of the toe of the Soil Lead Repository and extending south-southeast just down-gradient of the adit collapse area, also as shown on Figure 5. This line will provide data to better understand the depth and configuration of the colluvial/alluvial aquifer, and thereby groundwater conditions, in the down-gradient portion of the collapse area to support both design and construction of hydraulic control measures. This information will also be useful to support the characterizations and evaluations under the CSM.

Ambient vibrations from nearby sources such as moving vehicles and equipment result in shear and compression wave returns from subsurface materials to a linear array of geophones placed on the ground surface along the profile to be explored. These returns are assembled into a response spectrum that is analyzed by computer to evaluate shear and compression wave velocities (and thereby an index of density) of overburden materials and the approximate depth to interfaces of materials of varying density (e.g., competent strata such as intact bedrock). This information will be utilized to help characterize the apparent variation in density of the colluvium/talus as one of the bases for estimating shear strength for stability analyses of the existing steep slopes flanking the collapse area.

2.2.2 Resistivity

Four lines of resistivity profiling (RS-201, RS-202, RS-203, and RS-204) will be performed in the adit area in an attempt to identify the approximate depth of wetting from the water exiting the St. Louis Tunnel and seeping into the colluvium. This information, if the technique is successful, will be utilized together with water levels measured in monitoring wells in the collapse area and surrounding ground to contour what is currently believed to be a groundwater mound beneath and extending away from the collapsed adit area.

2.3 Geotechnical Drilling

2.3.1 Background

Substantial subsurface investigation and reconnaissance geologic mapping have been performed at the St. Louis Ponds site over at least the past 30 years, including a major program of investigations completed in 2011 (Part A of Atlantic Richfield Company, 2011b) and in 2012 (Atlantic Richfield Company, 2013b – submittal pending). Figure 5 shows the locations of explorations in 2012 (completed) and 2013 (proposed). Table 2 summarizes the field investigations scheduled for 2013. Explorations in the area west of the adit collapse area from 2011 and earlier are shown on Figures 3A and 3B in the 2013 Supplement to the FSP (Atlantic Richfield Company, 2013a). This previous subsurface investigation and reconnaissance mapping information was used, together with conceptual layouts and planning of potential future facilities, to develop the supplemental subsurface investigation and laboratory testing programs described in this 2013 Supplement to the AIP.

2.3.2 Inclined Borings

The objectives of the supplemental inclined drilling investigation for the St. Louis Tunnel area include the following:

- Further investigate the thickness and characteristics of the colluvial material covering the portal area

- Further define the location and configuration of the colluvial/bedrock surface (interface) in the vicinity of the St. Louis Tunnel

- Further define the geotechnical characteristics of the inferred lower-quality bedrock just east of the brow (contact of rock under the colluvium/talus) that required lagging during original tunnel construction (as shown on Figure 4) where the hydraulic control bulkhead may be located within the tunnel

- Further define the location of the floor of the St. Louis Tunnel to better target where access to the rock portion of the tunnel should be located to install the hydraulic control measures, including especially the bulkhead

- Provide additional locations for monitoring water levels, and if desired, sampling in-mine water and lime treatment solids that have accumulated in the lower reach of the tunnel

The supplemental drilling investigation required to further evaluate the subsurface conditions in the vicinity of the tunnel collapse area would include two angle core holes (CHI-101 and CHI-102C – approximately 245 and 230 inclined feet respectively, intersecting the tunnel approximately 300 to 370 feet from the portal). CH-101 will be drilled from an existing drilling pad located on the slope south of the St. Louis Tunnel; CH-102C will be drilled from an existing drilling pad located north of the tunnel, although its target will be a different section of the tunnel rock than that targeted by BAH-01. If the first two borings are successful in reaching their targeted intercepts, then a third boring (CHI-103 – approximately 260 inclined feet) may be drilled to investigate conditions at the fault zone located further into the tunnel (see Figures 3 and 4). The objective of this third boring would be to assess if support is needed in the faulted reach to further protect the integrity of the hydraulic control structure currently envisioned to be located in bedrock close to the colluvium/talus contact. If one or both of the first two borings do not intercept the tunnel, a decision will be made as to using the third boring instead to attempt once more to reach the tunnel closer to the rock brow.

An assessment will be made of the risks associated with this drilling prior to implementation, including working on steep terrain with minimal clearances on the drill pads and raveling/rolling of colluvium/talus (including cobble to boulder size rocks) from the surrounding natural and excavated slopes. Drilling pads and access roads will be inspected to accommodate the equipment to be used. A geotechnical engineer will also review the equipment loading and ground conditions to assure safe operation prior to mobilizing to the respective pads. Equipment inspections will be completed prior to coming on-site to insure good condition, safe and efficient operation, and control/prevention of fluid leakage. Appropriate measures, including use of trained and competent personnel, will be implemented to provide for the safety of the drilling operations.

The drilling conditions in the area targeted for this supplemental investigation are challenging because of the thickness and characteristics of the colluvial/talus material that covers the bedrock surface and the tunnel. For this reason, this supplemental drilling investigation will utilize one of the specialized drilling technologies outlined below that are designed to provide the best possible chance for successful completion of the boreholes and collection of the required subsurface information.

2.3.2.1 Drilling Methodology

This supplemental drilling investigation will be completed using the following equipment and procedures.

- Mobilize one or two specialized drill rigs: One option under consideration is to use a high-torque air rotary rig for setting casing, and a conventional rotary wash coring rig designed for the required angle boreholes. A second option is to use a single advanced, high power/torque rotary coring rig to both set casing and then perform the coring. The final selection will depend on the specific rig(s) available in the timeframe required and the capability of the drill crews.

- Geotechnical sampling of the overburden talus/colluvium as the holes are advanced with either the air rotary rig or rotary coring rig may not be practical. In that case, information on the physical properties of the materials encountered will be based on drill action and on the experience of the driller and the professional logging of the borehole and cuttings. The nature of the drill action (smooth, chattering, etc.), rate of penetration, color of the drill cuttings, and presence of free water in the drilling return (if present) will be recorded. Special attention will be paid if refusal or marked change in drill action or penetration rate is encountered.

- Threaded steel casing (5.5-inch OD HWT) would be set through the colluvial material and allow for completion of the rotary wash boring. The casing would be set using a specialized air rotary rig or advanced rotary coring rig as described above. The steel casing could be left as permanent casing at the completion of the hole if the borehole successfully intercepts the tunnel. If the tunnel is not intercepted by the borehole, the threaded casing would be removed at the completion of the drilling. To reduce the cost associated with permanently leaving the steel casing in place, the drillers will have the materials on-site to place schedule 80 PVC casing and remove the steel casing if desired. However, this option would only be used if it is determined in the field that the steel casing could be removed without damaging the completed borehole.

- After the casing is set through the colluvium to the bedrock surface, either a second high-rotation-speed core rig or the single advanced rotary core rig utilizing an HQ3 triple tube coring system would be used to continuously core and sample through bedrock from the colluvial/bedrock contact to the total depth of the boring. The HQ3 triple tube coring system is selected because this core sampling technique has proven to be the most reliable method for recovery of representative samples of the bedrock material. The completed unlined HQ3 borehole in rock will have a diameter of approximately 3.8 inches. Based on conditions encountered in BAH-01 drilled in 2011, it is assumed that this portion of the hole in rock will be adequately stable left unlined.

- The drilling contractor will be required to conduct downhole surveys at intermittent intervals (as each drill hole advances) designed to map the actual inclination and orientation of the borehole as drilling proceeds (see Section 2.3.2.2).

2.3.2.2 Downhole Imaging, Geophysical Logging, and Sampling

After the drilling is completed, each borehole planned for geophysical logging will be accessed by the downhole geophysical logging specialist using a customized logging vehicle with all of the necessary downhole tools, cables, truck-mounted motorized winch, and computer and monitor.

The downhole logging will be performed by lowering a suite of the selected downhole tools connected by a multi-conductor cable down the borehole or monitoring well using the motorized winch. The data collected during the survey will be transmitted to a computer and graphical display and reviewed by the geophysical-logging specialist in real time. This will allow for the geophysical-logging specialist to verify that the tools are operating as expected and make appropriate adjustments to the surveys as necessary to complete the survey data collection objectives.

Tools to be lowered into inclined boreholes penetrating into the St. Louis Tunnel will also be attached to a string of 1-inch threaded steel or fiberglass rods that will allow the tools to be safely inserted and removed from the void. Without the use of rods, it is possible that the tools suspended by only the multi-cable could be difficult to extract back out from the tunnel void and into the inclined boring.

Casing and boring conditions will be documented using a variety of downhole tools including the following:

- Optical and acoustic televiewer imaging systems and a borehole video camera will provide a 360-degree view of the borehole. The televiewer imaging systems provide additional data to evaluate fracture orientation and borehole deviation. The borehole video provides information on casing condition, hole visualization, and void identification.

- Natural gamma and conductivity (EM39) tools will provide information on soil and rock type, and conductivity may identify saturated versus unsaturated interfaces.

- If used, the thermal neutron tool may provide information on water saturation or moisture content, as well as lithologic information.

Water level measurements indicating 3 feet of excess head above the tunnel roof level at Boring AT-2 suggests that the tunnel in the vicinity of the planned intercept locations (and for hundreds of feet further upgradient) is partially or fully submerged. The optical televiewer and borehole video systems will be deployed to the bottom of the borings but may not provide useful imagery below the water level in the tunnel (if encountered) due to interference from suspended or colloidal solids. The acoustic televiewer imagery will provide information on discontinuities (bedding, joints, fractures) and voids only below the water level.

A water quality probe will be lowered into the tunnel through each inclined boring to measure temperature, pH, oxidation/reduction potential (ORP), and dissolved oxygen (DO); this tool will also measure fluid head with a pressure transducer so that water (or water/solids) level in the tunnel can be determined. This probe can also collect samples at a single or multiple depths for laboratory water (or water/solids) quality analyses if desired. If water quality samples are taken for laboratory analyses they will be acquired and processed in accordance with the current project surface and groundwater SAP (Atlantic Richfield Company, 2013c) and QAPP (Atlantic Richfield Company, 2013d).

If the tunnel is found to be partially or fully submerged at the locations intercepted, a colloidal borescope and a corehole dynamic flowmeter (CDFM) will be lowered into the tunnel in an attempt to measure horizontal and vertical fluid flow, respectively.

A separate downhole survey will be conducted after the drilling program is completed to scan the tunnel in the vicinity of the borehole intercepts. The downhole survey will consist of deploying sonar profiling and/or imaging tools down the borehole on rigid threaded rod, and into the tunnel. These tools provide imagery that, if successful, will allow measuring the distance from the portion of the tunnel sounded through the water to the sonar tool. Specialized mounting of the tools is being discussed with planned subcontractor COLOG (a downhole geophysical contractor with experience working at the 517 Shaft at the Site) to provide sufficient control of the orientation of the tools so that it may be possible to determine (or estimate as closely as feasible) the elevation of the floor and crown of the tunnel.

Laser scanning and optical imagery of the tunnel interior are likely not feasible if in fact the tunnel is full of water behind the debris blockage as currently inferred. If the tunnel is not fully submerged, then one or both of these tools may be deployed to further examine and map the unsubmerged portion of the tunnel.

If the new inclined borings are successful in encountering the tunnel, they may also be used, if feasible, to install pressure transducers to monitor seasonal water levels within the tunnel.

2.3.3 Vertical Boring

As part of the 2012 work, one vertical geotechnical exploratory boring (CHV-101) was also attempted between the portal structure and the collapsed part of the tunnel, starting at approximately the level of the top of the open part of the tunnel (elevation 8860+/-). The boring was advanced using hollow-stem auger drilling methods and sampled at typical 5-foot intervals through the talus/colluvium, but it met drilling refusal at a depth of 48 feet vs. the planned depth of 20 feet into intact bedrock. A field decision was made to finish the hole (labeled CHV-101S) as a shallow monitoring well (screened from 38 to 48 feet).

In 2013, it is planned to complete a nearby but deeper combined geotechnical boring/monitoring well, CHV-101D, to a minimum of 20 feet into bedrock. The boring will be completed with a piezometer constructed of factory slotted 2-inch nominal diameter PVC well screen set in the bedrock section; 10-foot screen length is assumed pending the results of the drilling. The screened interval will be isolated from the overlying alluvial/colluvial material by a bentoniteamended grout seal at the top of the bedrock section. This hole will be sampled by SPT or California barrel drive sampling more frequently than the monitoring wells described in Section 2.3.4 to provide additional information on the density of the colluvial material in the adit collapse area.

Downhole imaging and geophysical logging will be performed in borehole CHV-101D in accordance with the procedures described in Section 2.3.2.2 above. Imaging and logging tools planned include borehole video (for casing assessment), and natural gamma, conductivity (EM39), and thermal neutron (for lithology and saturation). Pending conditions encountered the water quality probe and colloidal borescope may also be used to sample and measure field parameters for groundwater and attempt to measure flow past the screened section.

2.3.4 Monitoring Wells

To further evaluate groundwater conditions in the St. Louis Tunnel collapse area, including contributions of flowing mine water from the open section of the tunnel into the talus/colluvium, and to proof the results of the surface geophysics, two of the four geotechnical monitoring wells removed from the 2012 exploration program will be installed (MW-201 and MW-203), plus three additional wells (MW-205, MW-206, and MW-207). Borings MW-205 and MW-206 will be drilled and sampled from the existing grade to a maximum of 20 feet into bedrock, using the sonic or possibly an alternative casing-advance method. These borings, together with CHV-101D, the planned inclined borings, existing boring BAH-01, and the planned ReMi profiles will provide a basis to estimate the location and inclination of the rock/colluvium interface at the adit collapse area and provide samples for laboratory testing of rock core samples to support design of the hydraulic control measures in the St. Louis Tunnel.

Slug tests will be performed in representative intervals below the water table of each of the planned new monitoring wells to assess the order-of-magnitude hydraulic conductivity range of the colluvium/talus material. Gravity permeability tests will also be attempted in representative unsaturated zones above the water table or between perched zones and the water table. Testing will be performed in general accordance with the procedures in Chapter 17 of the U.S. Bureau of Reclamation Engineering Geology Field Manual, Second Edition, Volume 2 (http://www.usbr.gov/pmts/geology/geolman2/Chapter17.pdf), or equivalent methods. Not more than two 10-foot intervals will be tested in each boring.

Open standpipe-type piezometers will be installed in all of the proposed new monitoring wells with screened (slotted) intervals within the colluvium/talus section selected based on the conditions encountered during drilling. The piezometers will be constructed with 2-inch nominal diameter factory slotted PVC pipe with appropriate sand packs and bentonite seals. If shallow, perched groundwater is encountered that is believed to be hydraulically separated from an underlying deeper water table, then one or more shallow wells may be installed adjacent to the well(s) completed below the deeper water table.

Downhole imaging and geophysical logging will be performed for all accessible existing and all new vertical monitoring wells in the adit collapse area as shown on Figure 5 in accordance with the procedures described in Section 2.3.2.2 above. Imaging and logging tools planned include borehole video (for casing assessment), and natural gamma, conductivity (EM39), and thermal neutron (for lithology and saturation). Pending conditions encountered the water quality probe and colloidal borescope may also be used to sample and measure field parameters for groundwater and attempt to measure flow past the screened section. If water quality samples are taken for laboratory analyses they will be acquired and processed in accordance with the current project surface water and groundwater SAP (Atlantic Richfield Company, 2013c) and QAPP (Atlantic Richfield Company, 2013d).

The primary purpose of these monitoring wells is to provide for water level measurements to determine if: 1) the flowing water observed in the open section of the tunnel is perched above the water level in the surrounding talus/colluvium; 2) if there is vertical connectivity between perched (if present) and deeper water table water levels in the colluvium/talus; and 3) if there is mounding of the water table within the colluvium and adjacent alluvium overlying bedrock. A secondary purpose is to gain an order-of-magnitude estimate of the range of hydraulic conductivity in the colluvium to support possible hydraulic calculations or modeling as part of the CSM work. This information is necessary both to support the design of hydraulic control measures and the CSM characterizations and evaluations.

2.3.5 Drilling and Sampling Methods

For vertical borings or monitoring wells, refer to Section 2.2.3 in the 2013 Supplement to the FSP (Atlantic Richfield Company, 2013a). For inclined borings, see the description of drilling and sampling methods specific to these specialized holes in Section 2.3.2 above.

2.3.6 Sample Handling and Custody

Refer to Section 2.2.5 in the 2013 Supplement to the FSP (Atlantic Richfield Company, 2013a).

3.0 Laboratory Testing Program

3.1 Geotechnical Testing

The following typical laboratory testing program is planned for selected soils, with variations to be determined by the Certifying/Design Engineer or his designee based on number, length, and type of samples recovered:

- **Moisture Content** – All recovered samples except clean gravels and rockfill (GP, GW); used for soil classification. ***Test Method:*** ASTM D2216 – Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

- **Atterberg Limits** – Representative clayey silt or clay samples (up to eight); used for soil classification. ***Test Method:*** ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

- **Hand Penetrometer or Torvane** – All tube samples, if recovered, of cohesive soils (native clays or clayey silts); used for soil classification and to estimate unconfined compressive strength. ***Test Method:*** Per equipment manufacturer's instructions.

- **Unconfined Compression/Dry Unit Weight** – Representative cohesive samples (up to six); used to estimate unconfined compressive strength and unit weight for slope stability and foundation/subgrade analyses. ***Test Method:*** ASTM D2166 – Standard Test Method for Unconfined Compressive Strength of Cohesive Soils.

- **Grain Size Analysis** – Representative coarse-grained (i.e., predominantly sand and gravel) samples, including miscellaneous fill/mine waste/demolition debris, sidehill colluvium, and landslide debris (up to 20); with determination of percent passing USCS No. 200 sieve; the results will be used for evaluation of foundation/subgrade stability, seepage analyses through colluvium, and evaluation of borrow sources to provide structural fill. ***Test Method:*** ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils.

- **Direct Shear** – Representative re-compacted sidehill colluvium, dike fill, and calcines samples (up to two samples of the minus 1-inch fraction). Density of re-compacted samples is to be based on field nuclear density and/or SPT results. The results are to be used for slope stability analyses of the adit collapse area or of access pits for future directional drilling equipment. ***Test Method:*** ASTM D3080/D3080M – Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions.

- **Triaxial Shear** – Representative compacted samples of the minus 1-inch fraction of colluvium, landslide debris (not failure plane material), dike fill, or calcines samples (up to two). The results are to be used for foundation bearing capacity and slope stability analyses. ***Test Method:*** ASTM D4767 – Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils.

- **Moisture/Density (Proctor) Testing** – Representative on-site colluvium, calcines, fill, waste rock, and possibly selected off-site borrow sources (up to four). These test results are to be used to establish density and moisture content criteria for re-use of processed colluvium as engineered fill. ***Test Method:*** ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 [600 kN-m/m^3]).

The following typical laboratory testing program is planned for selected rock core, with variations to be determined by the Certifying/Design Engineer or his designee based on number, length, condition, and lithology of core recovered:

- **Unconfined Compressive Strength with Elastic Modulus** – Up to eight samples of rock core (includes unit weight of core at as-recovered moisture content). ***Test Method:*** ASTM D7012 – Uniaxial Compression Test of Rock.

- **Tensile Strength** – Up to four samples of rock core. ***Test Method:*** ASTM D3967 – Standard Test Method for Splitting Tensile Strength of Intact Rock Core.

3.2 Laboratory Procedures

Receipt of the Chain of Custody Record (Table 4) will be acknowledged by the laboratory upon checking that all samples on the form were in fact received in good condition. If there are any discrepancies between the Chain of Custody Record and the samples received, the laboratory QC Officer shall immediately notify the Investigation Field Leader and the Certifying/Design Engineer so that resolution can be planned and implemented.

Laboratory tests will be completed per associated ASTM Standards as noted in Section 3.1, or other industry-recognized standards as agreed to by the Certifying/Design Engineer and approved by the EPA. Any variations in procedures per the standards that are judged warranted to accommodate sample size or condition, if any, shall be approved by the Certifying/Design Engineer and the EPA prior to implementation of the affected testing. If a test is run improperly, the laboratory QC Officer shall immediately notify the Certifying/Design Engineer so that resolution can be planned and implemented. If sufficient sample remains and the sample material quality or condition has not been compromised, the test will be re-run on the remaining material. If this is not feasible, additional sample will be acquired from the field under the direction of the Investigation Field Manager and shipped to the laboratory.

Testing turnaround time will be coordinated on a case-by-case basis between the Certifying/Design Engineer and the laboratory to achieve milestone dates in the currently approved EPA Work Plan Schedule dated January 10, 2012. Unless specifically authorized otherwise by the Certifying/Design Engineer, testing on all samples shall be completed no later than six months following receipt of the sample at the laboratory.

Specific method performance criteria are incorporated in the test method standards cited above.

Non-direct measurements are not planned during the laboratory testing program described herein.

Samples not tested will be retained at the geotechnical laboratory or at a secure off-site storage facility for a minimum of six months following receipt of the samples at the laboratory. The laboratory will be instructed to issue a notice to the Certifying/Design Engineer no less than 15 days prior to disposal of any samples after the expiration of the above retention period. If necessary for the purposes of the work under the UAO (EPA, 2011b), the Certifying/Design Engineer will direct the laboratory to extend the retention period or recover the samples for storage at an alternative secure location.

3.3 Quality Control

The Certifying/Design Engineer and Investigation Field Manager will approve the selected geotechnical laboratories prior to employing the laboratories and before commencing any testing activities. The role of the testing laboratory is to provide testing of soil and rock core samples recovered from the borings completed as part of this 2013 Supplement to the AIP.

The selected laboratories will be required to submit a laboratory quality assurance/quality control (QA/QC) plan to AECI and AECOM for review and approval prior to performing any work on the project. Any deficiencies identified will be corrected prior to commencing any testing. The Laboratory QA/QC Plan shall, at a minimum, address the following topics to the satisfaction of AECI and AECOM:

- **Sample Handling, Storage, and Custody** – Sample storage location; temperature and humidity controls; security; and documentation of receipt, transfer, and disposal
- **Instrument and Equipment Testing, Inspection, and Maintenance** – Equipment maintenance schedule; testing criteria; availability and location of spare parts; inspection of equipment before usage; individuals responsible for testing, inspection and maintenance; and how deficiencies will be resolved, re-inspections performed, and effectiveness of corrective action determined and documented
- **Instrument and Equipment Calibration and Frequency** – Identification of equipment, tools and instruments that need to be calibrated and frequency of calibration; how calibrations will be performed and documented, indicating test criteria and standards or certified equipment; and how deficiencies will be resolved and documented
- **Inspection and Acceptance for Supplies and Consumables** – If applicable, identification of critical supplies and consumables, noting supply source, acceptance criteria, and procedures for tracking, storing, and retrieving these materials

Quality control measures typically associated with chemical analytical testing are not applicable to the geotechnical testing to be performed under this 2013 Supplement to the AIP. These measures include, but are not necessarily limited to: blanks, spikes, or duplicates; development of control limits; and calculations for precision, bias, or outliers. Checks will be made by the laboratory during the course of their work to ensure that all required tests have been performed or are scheduled to be performed. If any samples are identified as missing, the laboratory QC Officer shall immediately notify the Certifying/Design Engineer and Investigation Field Manager so that resolution can be planned and implemented. If the missing sample is found critical by the Certifying/Design Engineer, then an additional sample will be acquired from the field under the direction of the Investigation Field Manager and shipped to the laboratory for testing.

4.0 Data Management

Project data, documents, and records are managed in accordance with AECOM's Project Document and Records Control Procedure attached to this 2013 Supplement to the AIP.

All field and laboratory data collected under this 2013 Supplement to the AIP will be compiled, scanned to digital format as necessary, and stored on an AECOM server in the Denver, Colorado, office per the practices described in Section 1.7.3. Scanned documents converted to digital data will be in pdf, tif, or jpeg format. Data and documents generated in digital form will be stored in their native format; duplicates of these native digital files will also be converted to pdf, tif, or jpeg format to facilitate data sharing while maintaining data integrity.

Originals of field logs will be collected upon completion of the field investigations and stored in the project filing system at AECOM's Denver, Colorado, office. The information on field boring logs will be entered into gINT logging software by someone other than the person who logged the boring in the field; the field logger will then review and edit the gINT log, and the final gINT log will be reviewed by the Certifying/Design Engineer or his designee.

Data management will be overseen by the AECOM Project Manager with the assistance of the Certifying/Lead Engineer.

5.0 Assessment and Oversight

5.1 Assessments and Response Actions

AECOM utilizes and maintains a quality management system (QMS) that is certified to the international ISO9001:2008 standard, yet sufficiently flexible to address the specific requirements of each project. Quality management is central to AECOM's project management approach, and our project team includes individuals assigned to specific quality roles under the QMS system.

Although not specifically required by AECOM's QMS program, the practice of reviewing field boring and test pit operations and field logs during the course of the investigation will be implemented for work under the 2013 Supplement to the AIP. This real-time assessment by the Investigation Field Manager and Certifying/Design Engineer (or their designees) provides the opportunity to identify any deficiencies in the field data collection effort in time to make any necessary corrections while subcontractors and staff are still in the field. Similarly, the Certifying/Design Engineer or his designee will maintain contact with and review in-progress results during the course of geotechnical laboratory testing.

Formal checking and review of all data and documentation prepared under this 2013 Supplement to the AIP are critical QMS activities. Quality-checking activities, which are all documented with two-level approvals, include checking:

- Figures and drawings to confirm content, dimensions, and details
- Studies/reports for content, logic, clarity, and soundness of recommendations, as well as grammar, punctuation, and format
- Calculations to verify correctness and completeness of mathematics, methodology, selection of software, application of standards and codes, and general approach

Additionally, all deliverables undergo a final verification check before they are submitted. An independent reviewer – for the purposes of this 2013 Supplement to the AIP, the QA Manager (in AECOM's QMS terminology, the Project Quality Representative [PQR]) – evaluates the deliverable for completeness and consistency, adherence to quality requirements, and resolution of comments. As needed, the QA Manager communicates any findings in need of remediation to the Certifying/Design Engineer, who is then responsible for making sure the appropriate changes are made. Once the QA Manager is satisfied that all requirements have been met, a Deliverable Release form is signed by the QA Manager and transmitted to the Certifying/Design Engineer for review, and then to the AECOM Project Manager, who is ultimately responsible for the final overlook, approval, and submittal.

This final independent evaluation assesses the submittal's state of readiness without diminishing the Certifying/Design Engineer's or AECOM Project Manager's accountability for the quality of the work being released.

5.2 Assessment Responsibilities

AECOM's approach to project quality management designates the following responsibilities among project team members:

- **Planning and Approach** – Shared by AECOM Project Manager, Project Director, Team Leads, and QA Manager
- **Development and Execution** – Shared by AECOM Project Manager, Team Leads, and Staff
- **Checking** – Independent Reviewers
- **Review** – Shared by AECOM Project Manager and Team Leads
- **Verification** – Shared by AECOM Project Manager and QA Manager

5.3 Reports to Management

The QA Manager will prepare a monthly report on the status of QA activities relevant to the project and submit the report to the AECOM Project Manager and Certifying/Design Engineer. The report will document QA activities over the preceding month, identify any deficiencies in the QA implementation, and recommend actions to address deficiencies.

6.0 Data Validation and Usability

6.1 Data Review, Verification, and Validation

All field and laboratory data generated under this 2013 Supplement to the AIP will be reviewed by an appropriately experienced and qualified professional staff member assigned by the AECOM Project Manager or by the Certifying/Design Engineer. This staff will be independent and will have had no direct involvement in the technical work being reviewed. Data will be compared to previous data collected at the Site and developed in the geotechnical laboratory to identify potential "red flags" or apparent errors or outliers. If such conditions are noted, the Investigation Field Manager and Certifying/Design Engineer will be immediately notified, and they will develop an appropriate response to further investigate the validity of the data in question and correct it if necessary. Corrective action may range from simply correcting math errors to discarding the data in question.

6.2 Verification and Validation Methods

Data generated under this 2013 Supplement to the AIP will be verified and validated by having appropriately qualified and experienced staff review the data and document any questions, concerns, corrections, or recommendations for further assessment that are appropriate. The documentation may involve direct mark-up on boring logs, data sheets, or data summaries, and/or preparation of a QA memorandum describing the issue in greater detail. Calculations will be checked and evidence of the checking will be made on a copy of the calculation sheet or digital file to include a check mark or other clear identifier and the initials of the reviewer performing the check. Evidence of the calculation methods and checks shall be documented on a Calculation Cover Page and Calculation Review Checklist (included in the attachments).

6.3 Reconciliation with User Requirements

Data that are suspect as to their validity will either be deleted from the project files, or flagged with appropriate data validation qualifiers and/or documented in narrative form to identify the nature and scale of the uncertainty in the reliability of the data. Data qualifiers will be implemented if suspect data cannot be confirmed as invalid, and has potential value to data users. The qualifiers will indicate data limitations and the appropriate level of caution for data users. If flagging is used, it will accompany all distribution of that data to known or potential users.

7.0 References

Atlantic Richfield Company (2013a). *2013 Supplement to the Field Sampling Plan, Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. May 31.

Atlantic Richfield Company (2013b). *2012 Investigations, Analyses and Evaluations (Engineering Geologic and Geotechnical Field Investigations and Laboratory Testing). Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. (Submittal pending.)

Atlantic Richfield Company (2013c). *Sampling and Analysis Plan for Surface Water and Groundwater, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. May 23.

Atlantic Richfield Company (2013d). *Quality Assurance Project Plan for Surface Water and Groundwater, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. May 23.

Atlantic Richfield Company (2012). *Supplement to Investigation Plan for Collapsed Adit Area at St. Louis Tunnel, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. July 3.

Atlantic Richfield Company (2011a). *Investigation Plan for Collapsed Adit Area at St. Louis Tunnel, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. August 29.

Atlantic Richfield Company (2011b). *2011 Investigations, Analyses and Evaluations (Part D – Adit and Portal Investigation Report). Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. December 30.

U.S. Bureau of Reclamation (2001). *Engineering Geology Field Manual, Second Edition, Volume II.* U.S. Department of the Interior, Bureau of Reclamation.

U.S. Environmental Protection Agency (EPA) (2011a). *Removal Action Work Plan. Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado.* March 9.

U.S. Environmental Protection Agency (EPA) (2011b). *Unilateral Administrative Order for Removal Action, U.S. EPA Region 8, Docket No. CERCLA-08-2011-0005; Rico-Argentine Site, Dolores County, Colorado.* March 23.

TABLES

Table 1: Data Quality Objectives and Criteria

No.	Data Quality Objective (DQO)	Performance Description	Criteria
1	Characterize extent and depth of subsurface materials in areas and to depths investigated	Perform geologic mapping, drill borings, and conduct geophysical surveys	Spatial appropriateness (location) and adequacy of extent (number of locations, depth of drilling, and geophysical profiling)
2	Collect representative samples of selected subsurface materials for laboratory testing and archiving for future possible testing and visual examination	Acquire samples from borings utilizing appropriate techniques and equipment (e.g., grab samples of cuttings, drive samples – standard penetration test [SPT] and California barrel, Shelby tube samples); perform in situ SPTs	Sample(s) and SPT(s) from each primary stratigraphic unit encountered using appropriate technique/equipment; sampling interval with depth; sample size
3	Measure depth to groundwater; provide ability to sample groundwater	Construct piezometers or monitoring wells with screened intervals in targeted aquifer zones	Appropriateness of selected screened intervals to allow monitoring of groundwater levels and sampling of groundwater in targeted aquifer zone(s)
4	Estimate approximate depth of saturated overburden	Complete geophysical resistivity surveys in separate lines flanking the adit collapse area outside of the designated terrain trap; depth of penetration of signal estimated at 20% of the resistivity line length	Spatial appropriateness (location and thoroughness of mapped areas), and adequacy of extent (number of locations mapped/sampled, depth of influence vs. length of resistivity lines)
5	Estimate approximate depth of intact bedrock	Complete geophysical Refraction Microtremor (ReMi) lines flanking the adit collapse area, outside of the designated terrain trap; depth of penetration is approximately 50% of the ReMi line length	Spatial appropriateness (selected ponds based on accessibility and results of calcines mapping), thoroughness of coverage in profiled areas (spacing of traverses in grid pattern), and adequacy of extent (depth to interpret presence of intact bedrock)
6	Determine geotechnical properties of selected, representative materials acquired in borings per DQO 1	Perform geotechnical testing in the laboratory including as appropriate, but not limited to: moisture content, gradation, Atterberg limits, consolidation, hydraulic conductivity, and shear strength (soils); and unconfined compressive strength and tensile strength (bedrock)	Representativeness (samples from selected units and depths); testing per recognized industry standards (ASTM, Corps of Engineers, Bureau of Reclamation, etc.)
7	Document findings of field and laboratory investigations	Prepare 2013 Geotechnical Investigations Report describing scope, methods, and results of all field exploration and laboratory testing	Thoroughness and clarity of report

Table 2: 2013 Field Investigations Summary

Exploration #	General Location	Depth (Estimated)	Rig Type	Monitoring Well	Notes
CHV-101D	Collapsed adit area	As needed for 20 feet into bedrock	Sonic / HQ Coring	Yes	Vertical boring
CHI-101	Prepared pad (see Figure 5)	245 feet at 18° below horizontal (estimated) to existing tunnel	TBD	Yes, casing remains	Inclined boring using skid or track rig
CHI-102C	Prepared pad (see Figure 5)	230 feet at 21.5° below horizontal (estimated) to existing tunnel	TBD	Yes, casing remains	Inclined boring using skid or track rig
CHI-103	Prepared pad (see Figure 5)	260 feet at 19.5° below horizontal (estimated) to tunnel/fault zone	TBD	Yes, casing remains	Inclined boring using skid or track rig (complete only if CHI-101 and CHI-102C are successful)
MW-201	North side of collapsed adit	El. 8800 or minimum 20 feet below first groundwater table	Sonic	Yes	Screened interval based on conditions encountered during drilling
MW-203	South side of collapsed adit	El. 8800 or minimum 20 feet below first groundwater table	Sonic	Yes	Screened interval based on conditions encountered during drilling
MW-205	North side of collapsed adit	As needed for 20 feet into bedrock	Sonic / HQ Coring	Yes	Screened interval based on conditions encountered during drilling
MW-206	South side of collapsed adit	As needed for 20 feet into bedrock	Sonic / HQ Coring	Yes	Screened interval based on conditions encountered during drilling
MW-207	Northwest of collapsed adit	El. 8800 or minimum 20 feet below first groundwater table	Sonic	Yes	Screened interval based on conditions encountered during drilling
RM-201	Parallel to north side of collapsed adit	Up to 150 feet	N/A	N/A	ReMi profiles by AECOM
RM-202	Across axis of collapsed adit	Up to 150 feet	N/A	N/A	ReMi profiles by AECOM
RM-203	Across axis of collapsed adit	Up to 150 feet	N/A	N/A	ReMi profiles by AECOM
RM-204	Across axis of collapsed adit	Up to 150 feet	N/A	N/A	ReMi profiles by AECOM
RS-201	Parallel to north side of collapsed adit	Up to 50 feet	N/A	N/A	Resistivity profiles by AECOM
RS-202	Across axis of collapsed adit	Up to 50 feet	N/A	N/A	Resistivity profiles by AECOM
RS-203	Across axis of collapsed adit	Up to 50 feet	N/A	N/A	Resistivity profiles by AECOM
RS-204	Across axis of collapsed adit	Up to 50 feet	N/A	N/A	Resistivity profiles by AECOM

Table 3: 2013 Geotechnical Investigations Data Report Proposed Table of Contents

Table 4: Chain of Custody Record

ANDERSON ENGINEERING COMPANY INC.

977 West 2100 South
Salt Lake City, UT 84119
(801) 972-6222
FAX (801) 972-6235

CHAIN OF CUSTODY RECORD

COC# ______
Page ____ of ____

Client: ______
Project: ______
AECI Contact ______

Lab Name: ______
Lab Contact: ______
Lab Address: ______

Matrix Codes
(W) Water
(S) Soil
(L) Liquid

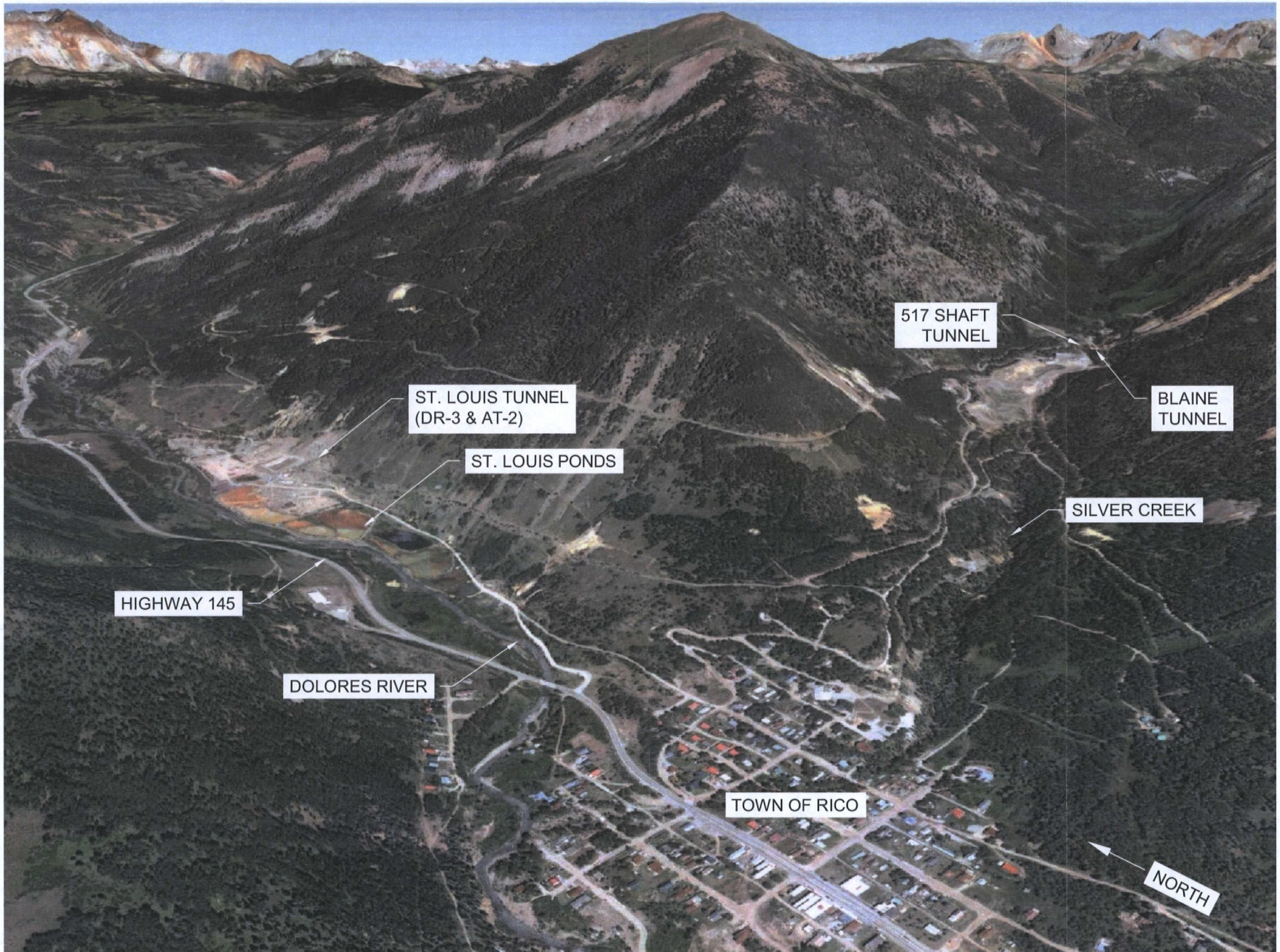
QC: (circle one) I II III IV

Field Location	Field Sample ID Number	Date	Time	Matrix	No. of Containers	Analysis Requested										COMMENTS

Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	Special Instructions
Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	
Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	
Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	

FLD-002

FIGURES



IMAGERY COURTESY OF GOOGLE EARTH PRO

RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE INVESTIGATION PLAN FOR COLLAPSED ADIT AREA AT ST. LOUIS TUNNEL

FIGURE 1 - RICO-ARGENTINE MINE SITE LOCATION MAP

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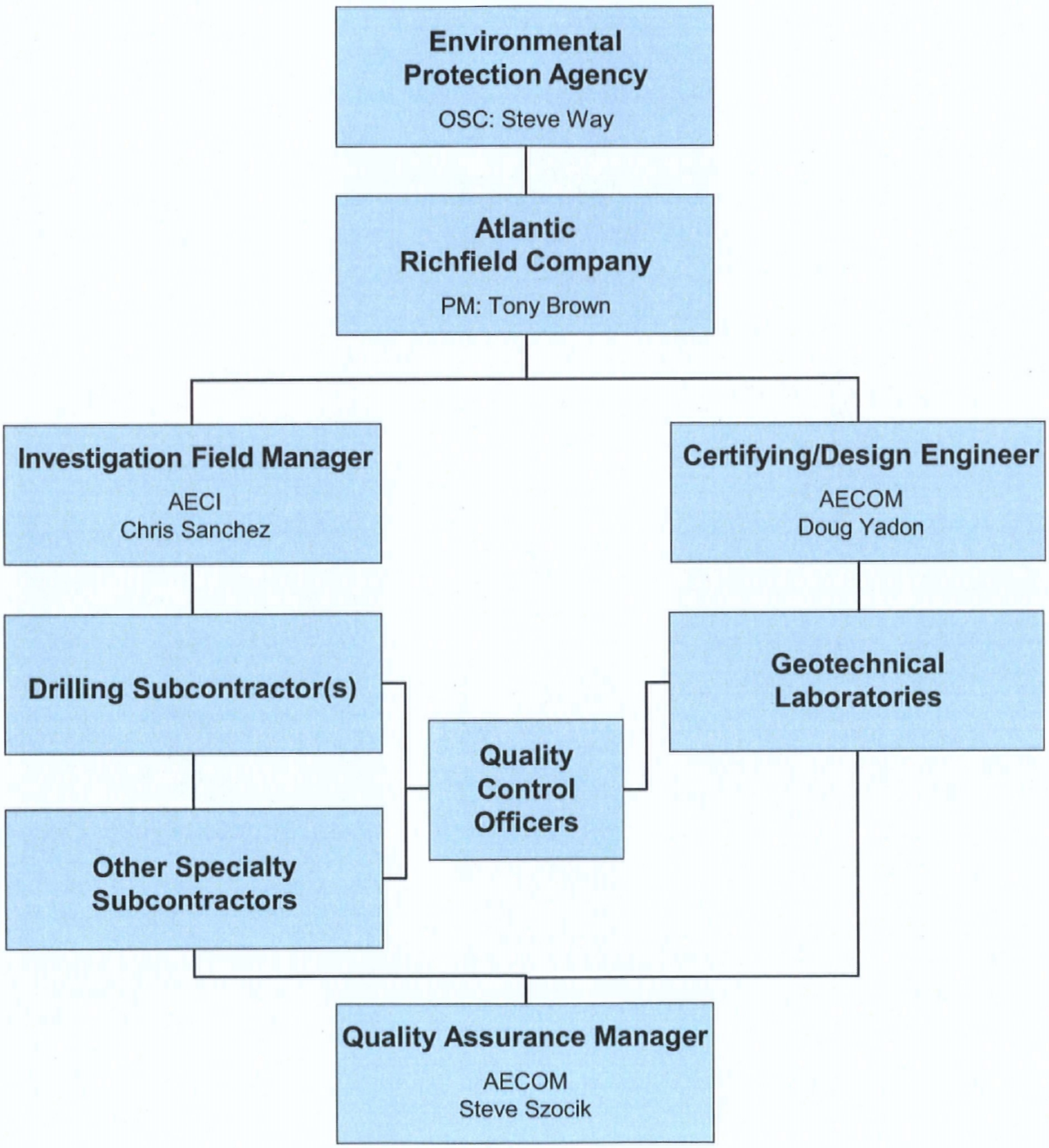
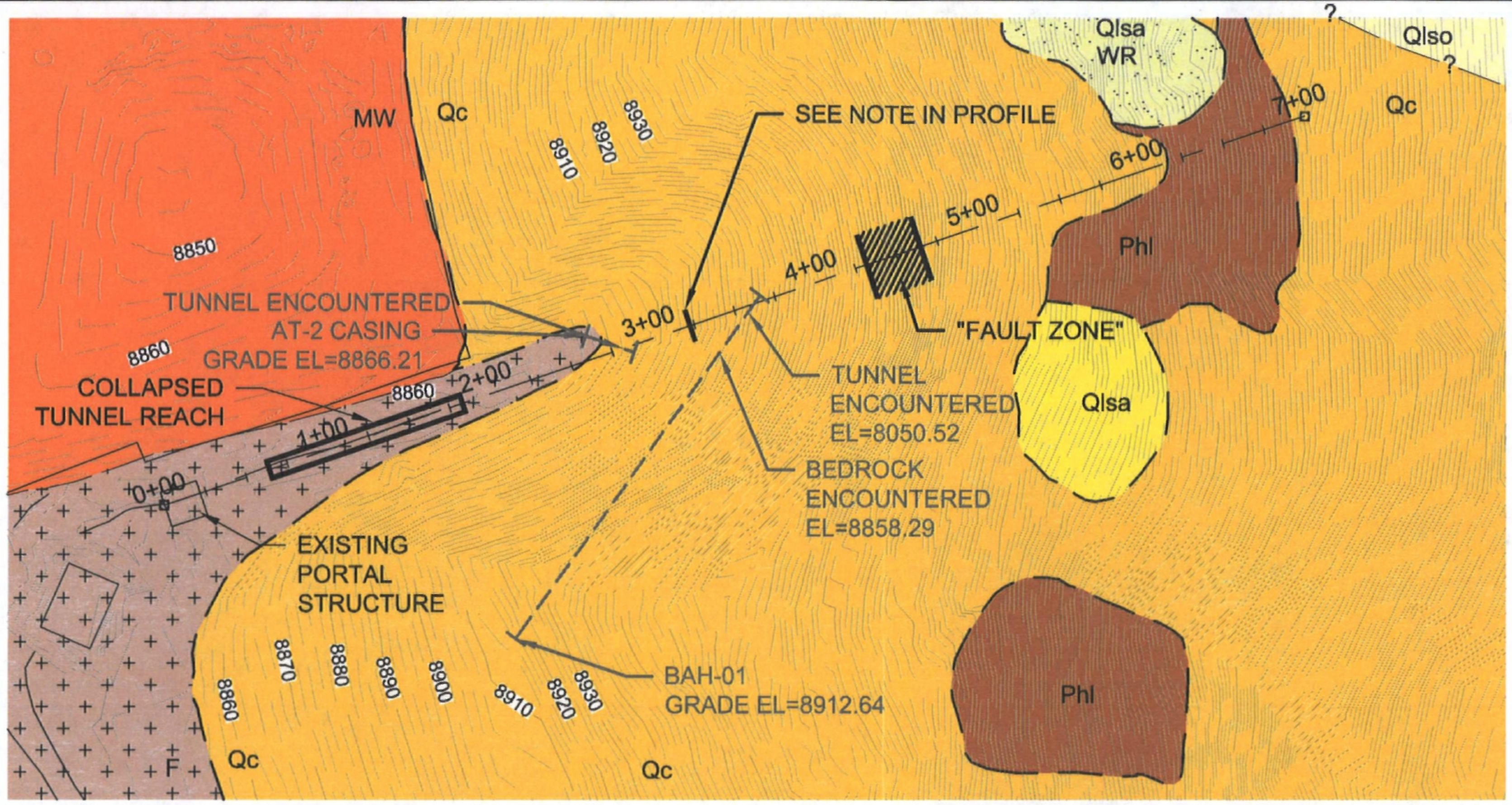
Figure 2: AIP Organization Structure





LEGEND:
- FILL
- MINE WASTE
- WASTE ROCK
- Phl
- Qc
- Qlso
- Qlsa

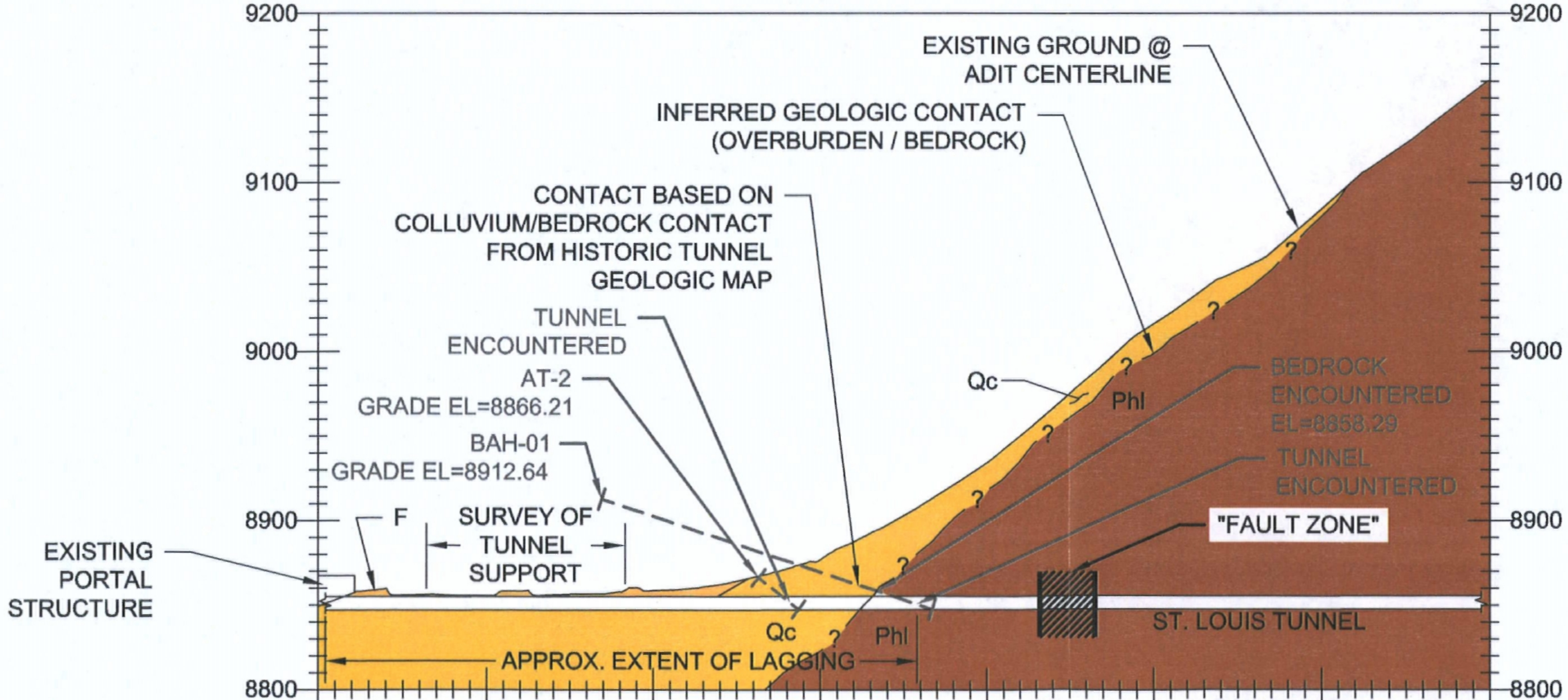
PLAN

SCALE: 1"=100'

0 100' 200'

SCALE: 1" = 100'

N



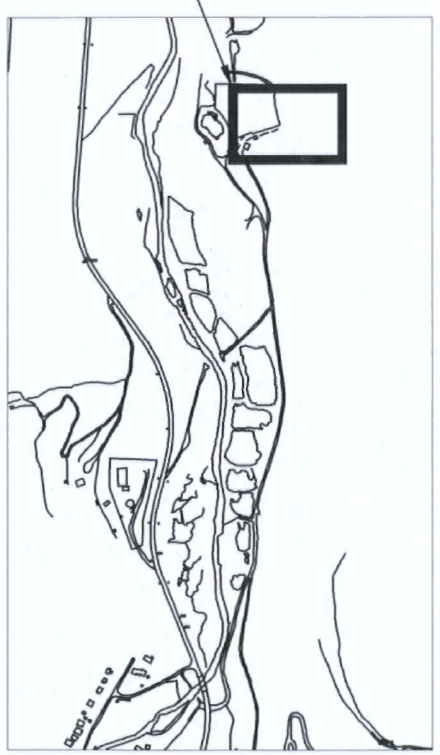
PROFILE

SCALE: 1"=100'

0 100' 200'

SCALE: 1" = 100'

PLAN AREA



KEYMAP

NOT TO SCALE

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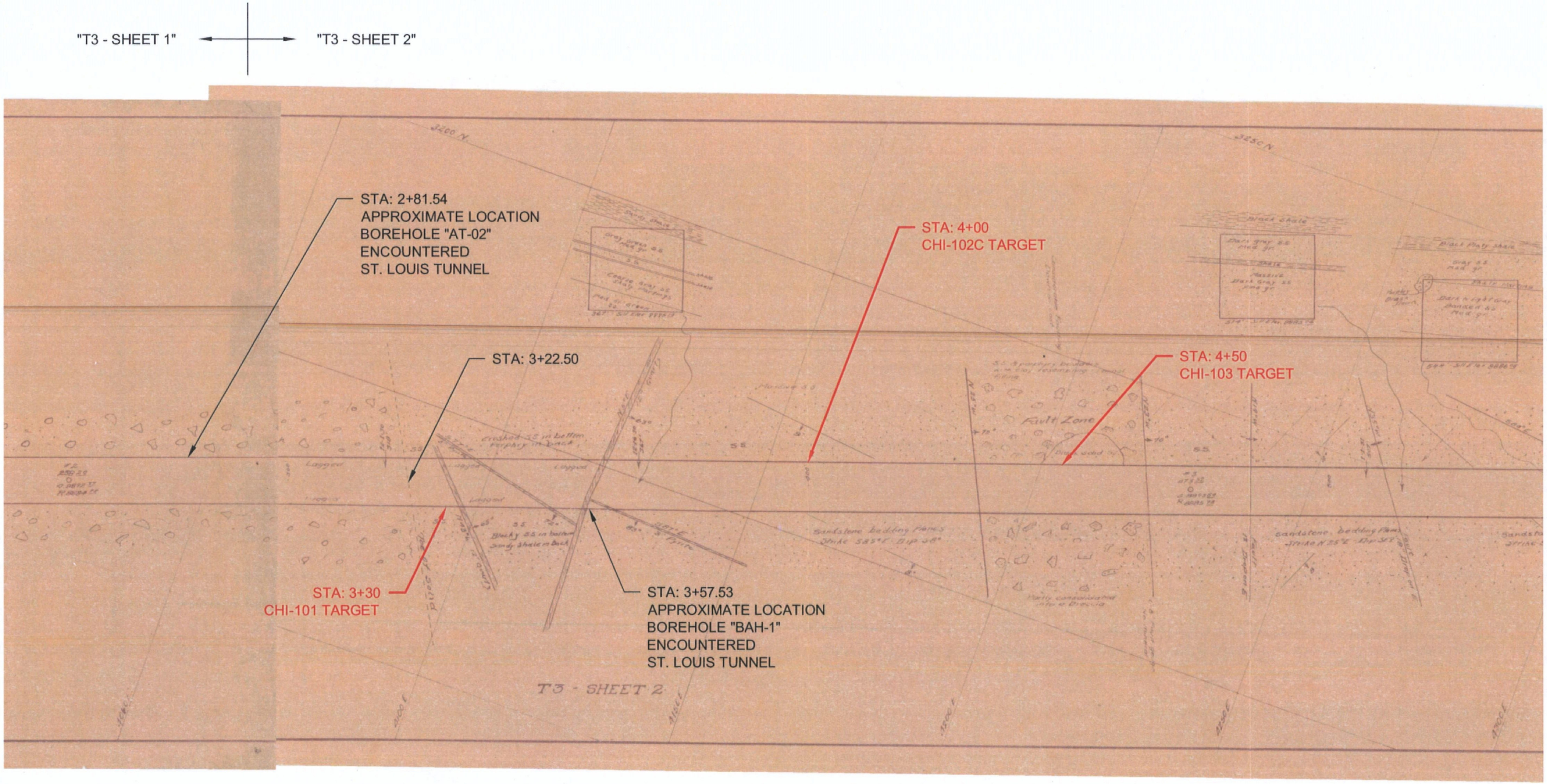
RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE INVESTIGATION PLAN FOR COLLAPSED ADIT AREA AT ST. LOUIS TUNNEL

FIGURE 3 - ADIT COLLAPSE AREA GEOLOGIC PLAN & PROFILE



RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE INVESTIGATION PLAN FOR COLLAPSED ADIT AREA AT ST. LOUIS TUNNEL

FIGURE 4 - HISTORIC TUNNEL GEOLOGIC MAP

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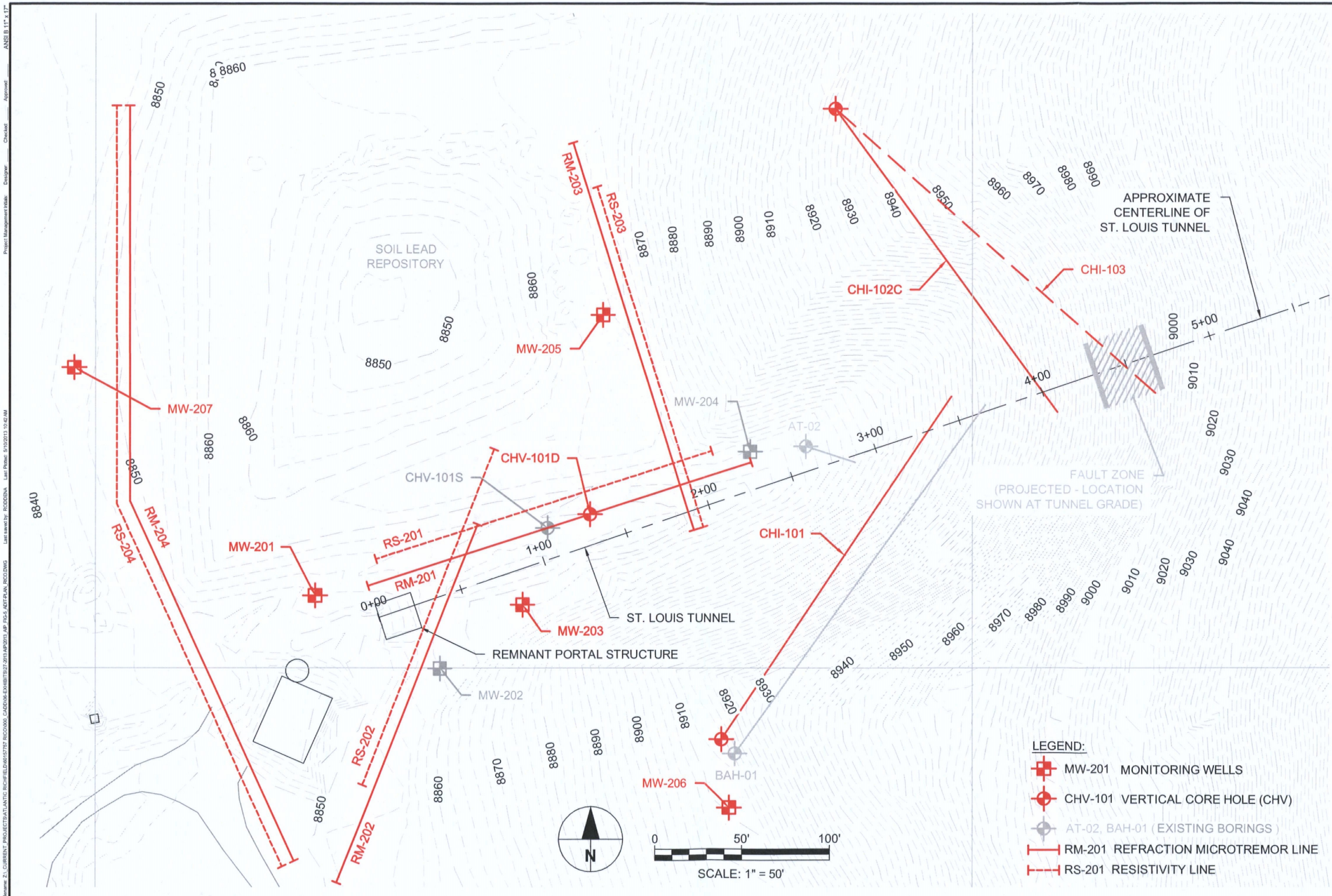

RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE INVESTIGATION PLAN FOR COLLAPSED ADIT AREA AT ST. LOUIS TUNNEL

FIGURE 5 - 2013 FIELD INVESTIGATION PLAN

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MAY 2013

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ATTACHMENTS

Project Document and Records Control Procedure

Project Document and Records Control Procedure Q2-222-PR

1.0 Purpose and Scope

1.1 The purpose of this procedure is to define a standard methodology to enable all project stakeholders to have access to relevant and current project information and to ensure the status of the information is readily identifiable.

1.2 This procedure is to be applied to all documents and records (hard and soft/electronic copy) of internal or external origin that may affect the quality of project work.

1.3 This procedure provides an overview of the requirements for the management, control, storage and retention of information to:

- Provide identification and traceability of project-related information;
- Control document change, revision status and distribution;
- Prevent loss or unintentional use of information;
- Protect the confidentiality, authenticity and integrity of information;
- Provide for efficient storage, retrieval and archiving of project records; and
- Prevent access by unauthorized parties.

The Project Plan procedure shall be used to address the control, maintenance and destruction or final disposition of confidential or sensitive records, all in accordance with local legislation, where applicable. Specific project requirements for the control (maintaining, archiving and disposition) of project records shall be documented in the Project Plan. Control of the corporate level Integrated Management System (IMS) documents and records is addressed under procedure G2-001-PR IMS Document and Records Control.

2.0 Terms and Definitions

2.1 **Controlled Document** – A document that shall be identified, filed and distributed to provide accountability, retrievability and evidence of receipt at locations where they are needed. Examples of controlled documents include the Project Plan, contract with the client, scope change authorizations, subconsultant agreements, background drawings, master specifications, submittal documents, etc.

2.2 **Controlled Records** – Documentation generated or received as evidence of fulfillment of a specific contractual obligation or IMS/PDS (project delivery system) requirement. Records are evidence of results achieved or activities performed. Examples include minutes of meetings, transmittal letters, calculation review checklists, completed project delivery forms etc.

2.3 **Confidential, Sensitive or Classified Project Documents/Records** – Documents/Records that include information or data that is potentially sensitive or confidential. Examples may include security information, commercially sensitive proprietary information, details of public/private infrastructure, fire/life safety data, critical financial data, personal information, government classified documents, claims communication, etc.

2.4 **Correspondence** – Project letters, faxes, emails, data transmissions, memos, records of conversation and minutes/notes of meetings.

2.5 **Imaging Records** – An electronic document imaging system is a computer-based configuration of equipment and software that stores machine-readable document images and their associated character-coded index data for on-demand retrieval. Electronic images can be computer generated or created through document scanning.

2.6 **Project Input** – Incoming information or data received from a client, joint venture partner, subconsultant or other source that contributes to the project work and deliverables.

2.7 **Project Work** – Reports, drawings, specifications, data sheets, models, virtual deliverables, calculations or other output that serves as input to subsequent project stages or shall be delivered to the client.

2.8 **Project File Index** – A list of file numbers or, as may be generated by an electronic system, numbering and naming conventions used to facilitate filing and retrieval of documents and records on the project and across the company

3.0 References

3.1 Project Plan Procedure

3.2 Checking and Verification Procedure

3.3 Project Closeout Procedure

3.4 Geography/Business Line Document Retention Protocol

4.0 Procedure

4.1 Document Control and Logging Requirements – All documents not already listed in the IMS as a project document requiring control shall be defined by the **Project Manager** and described in the Project Plan. Such documents shall be controlled throughout the life of the project.

The use of a document control log is one method that can assist in the control process. If local office practice or project-specific practice dictates, such documents shall be tracked using a log.

4.2 Project Document Control Filing System – The **Project Manager** shall ensure a document control filing system is established at the start of the project to address the filing of all documents and records expected to be developed or received during the life of the project. A Project File Index shall be used as the basis for the project's filing system.

4.3 Work Sharing – The means of controlling documents and records for work shared between Business Lines, Geographies and offices shall be addressed in the Project Plan. The **Managing Office** (i.e., holding the contract) shall be responsible for the filing and control arrangements of project-related documents and records.

4.4 Incoming Documents and Data – The **Project Manager** shall ensure that incoming project documentation is clearly identifiable prior to filing. Project input shall be reviewed in accordance with the Checking and Verification Procedure and annotated as such prior to use/inclusion in project work.

In addition, when electronic project input/media, such as CDs, portable hard drives, etc., are received, a virus check shall be carried out and the media annotated as such prior to use.

Project input received from the client or other third parties and subject to return at project completion shall be clearly identified as client/third party property and shall be verified and stored in a manner that safeguards the integrity of the property until it is returned to the provider. Should this information be lost, damaged or found to be unsuitable, then it shall be reported to the provider at the first opportunity and appropriate records of correspondence maintained.

4.5 Electronic Document Control Filing System – Some projects utilize electronic and/or web-based systems (extranets) in part or in full as their method of filing. In these cases, the overall intent of this procedure shall be met and the filing system shall be set up consistent with the Project File Index. Where both hard and electronic files are kept, the Project File Index shall be the same for both types of files. When a combination of electronic and hard copy files are used on a project, the two systems, when merged, represent the complete project file. Electronically saved documents/records shall:

- Be final "as-issued" versions (not drafts) showing appropriate dates and signatures (typically converted from hard copy by scanning) or
- Contain secure, encrypted and dated electronic signatures; and
- Be stored on a secure, protected and backed-up company server or externally hosted server, such as Aconex, on a temporary basis. Storage of such documents on employee hard drives is not acceptable.

4.6 Electronic Communications – Electronic communications such as emails shall be filed and retained in a project specific file directory. This shall be accessible to designated project team members. If a project-specific electronic directory has not been implemented, all electronic correspondence, including attachments, that potentially impacts any of the following shall be printed and placed into the project file:

- Contract requirements;
- Budget;
- Scope;
- Critical design inputs;
- Client or agency directives;
- Client or agency approvals;
- Comments on deliverables; and/or
- Client complaints.

4.7 Identification and Logging – The project number and file number shall be annotated on all records and documents. Project documents shall be indexed and logged if required by the office-specific document control filing system or if the **Project Manager** elects to utilize logging as a control tool for the project.

4.8 Collection and Filing – Documents required to be maintained and retained shall be collected by the **Project Manager** or delegated for filing as they are created or received. All project documents are to be filed in accordance with the project document control filing system — employees are not permitted to keep private files.

4.9 Duplicative Records – Duplicate file copies may be needed when documents or records meet more than one file folder definition, or when documents are submitted via correspondence. For example, when a subcontractor submits a utility report, it may be filed in the chronological correspondence file as well as a technical file location. If a document control log is not in use for the project (which would clearly identify the location of the document for retrieval), then the **Project Manager** may choose to keep the document in one location and place a note in the other file location identifying where it can be found.

4.10 Oversized Items, Copies of Large Documents, Manuals, Vendor Samples, Etc. – In some cases it is not feasible to maintain items in filing cabinets. In these cases, a note shall be placed in the file in the appropriate filing location identifying the actual location of the item. Standard oversized items, such as drawings, do not require a note to the file as it is understood that these are segregated in flat files, hanging files or stick files.

4.11 IMS/PDS (project delivery system) Forms – Forms shall be signed and dated in the appropriate space on the forms. Signatures shall be provided by one of the following methods:

- In ink and placed in a hard copy file or faxed to another destination;
- In ink and scanned for electronic filing or transmission;
- Using the signer's electronic signature, provided this method is controlled and secured by the signer;
- Using a typed signature provided that the email transmitting the form is included in the project file (hard copy or electronic) with the form; one email will be sufficient evidence for multiple typed signatures provided all signatories are copied on the email; or
- Using a system-generated signature that is secure and cannot be copied.

4.12 Critical Documents and Records – Documents and records the **Project Manager** deems "critical" by nature of their uniqueness, cost to replace, or potential harm to the company if lost or damaged should be protected by appropriate special measures. These measures may include:

- Fire proof cabinets;
- Duplicate storage;
- Off-site storage;
- Additional electronic backup (in a secondary location); and/or
- Lockable storage.

4.13 Confidential, Sensitive or Classified Documents/Records – When documents or records of a confidential or sensitive nature are expected to be created or received during the course of a project, their control, protection, distribution and destruction shall be clearly outlined in the Project Plan. Government classified documents require special handling and will also be addressed in the Project Plan or in supplemental procedures issued by the appropriate AECOM business unit.

4.14 Project Closeout and Archiving – Upon project completion, the **Project Manager** shall ensure that files are prepared for long-term storage in accordance with the Project Closeout Procedure and Geography/Business Line document retention protocol.

4.15 Printing in General – Always consider the environment before printing, use double-sided prints where practicable and recycle redundant/waste paper whenever you can.

5.0 Records

None

6.0 Attachments

None

Calculation Cover Sheet

AECOM

CALCULATION COVER PAGE

BASIC INFORMATION			
Project	Job No.	TTP No. (if req'd)	Total pages includes attachments Page 1 of ______
Client	Department/Discipline		Calculation No.
Subject / Title			

Calculation Rev. No.	Originator	Discipline Reviewer	Technical Peer Reviewer (if req'd)	Confirmation Req'd Y/N

Calculation Objective:

Calculation Methodology and data to be confirmed:

References / Inputs/ Field Data:

Conclusions including confirmations to be obtained:

This calculation is complete and ready for Discipline Review:

Originator ______________________________
Signature / Date

Calculation Review Checklist

AECOM

CALCULATION REVIEW CHECKLIST			
PROJECT		JOB NO.	
CLIENT	DISCIPLINE	CALCULATION NO. ______ REV. NO. ______	
SUBJECT/TITLE		TTP NO. (if used) ________	
ORIGINATOR		DISCIPLINE REVIEWER	
DISCIPLINE LEAD		INDEPENDENT CALCULATION PREPARER (if used)	

Discipline Review

	Yes	No	N/A
1. Is the calculation in accordance with a standard approach to preparing the design?	☐	☐	☐
2. Have input data and information been verified and accepted?	☐	☐	☐
3. Have assumptions requiring follow-up been reviewed and confirmed?	☐	☐	☐
4. Are the mathematics correct?	☐	☐	☐
5. Are results and conclusions consistent and reasonable considering the inputs and approach?	☐	☐	☐
6. Have the originator and the checker/reviewer signed and dated the calculation?	☐	☐	☐
7. Have all previous internal review comments been addressed and closed out with the originator?	☐	☐	☐
8. Have all previous client review comments been addressed and closed out?	☐	☐	☐

Explain "No" responses:

Discipline Reviewer ______________________________
Signature/Date

Independent Calculations **(in lieu of Discipline Review)**

A separate, independent set of calculations has been prepared, validating the original calculations.

Independent Calculation Preparer ______________________________
Signature/Date

Note: Independent Peer Reviews, where required, and Discipline Lead concurrence are recorded on the Deliverable Release Record (Q3NA-351-FM7) which is required for all deliverables.